REMARKS

In the last Office Action, claim 36 was rejected under 37 C.F.R. §1.75 as being a substantial duplicate of claim 3. Claims 31-32 were rejected under 35 U.S.C. §112, second paragraph, for indefiniteness. Claims 1-4, 31 and 36 were rejected under 35 U.S.C. §102(b) as being anticipated by U.S. Patent No. 6,670,717 to Kane et al. ("Kane"). Claim 5 was rejected under 35 U.S.C. §103(a) as being unpatentable over Kane in view of U.S. Patent No. 5,229,607 to Matsui et al. ("Matsui"). Claim 8 was rejected under 35 U.S.C. §103(a) as being unpatentable over Kane in view of U.S. Patent No. 6,207,575 to Yang et al. ("Yang"). Claims 6-7 were rejected under 35 U.S.C. §103(a) as being unpatentable over U.S. Patent No. 4,933,565 to Yamaguchi et al. ("Yamaguchi") in view of Yang. Claim 32 was rejected under 35 U.S.C. §103(a) as being unpatentable over Kane in view of U.S. Patent No. 6,986,280 to Muckenhirm. Claims 33-34 were rejected under 35 U.S.C. §103(a) as being unpatentable over Kane in view of U.S. Patent No. 6,437,343 to Okazaki et al. ("Okazaki"). Claims 33 and 35 were rejected under 35 U.S.C. §103(a) as being unpatentable over Kane in view of Japanese Patent No. 10-223170 to Hitachi. Claim 37 was rejected under 35 U.S.C. §103(a) as being unpatentable over Yamaguchi in view of Yang and further in view of U.S. Patent No. 5,683,547 to Azuma et al. ("Azuma").

In accordance with the present response, independent claims 1 and 6 have been amended to limit the claims to forming and observing a "target cross-section" (claim 1) and exposing and observing a "target cross-section" (claim 6). The preambles of claims 1-8, 31-35 and 37 have been suitably revised to conform to the foregoing amendment to claims 1 and 6. Claim 2 has been amended to conform to the language of base claim 1 by changing "desired" to "predetermined". Claims 31-32 have been amended to overcome the indefiniteness rejection. Claim 36 has been canceled, thereby rendering the objection under 37 C.F.R. §1.75 moot. A new abstract which more clearly reflects the invention to which the amended claims are directed has been substituted for the previously submitted abstract.

Applicants most respectfully request entry of the foregoing amendments since they merely comprise amendments to limit claims 1 and 6 to forming and observing a "target cross-section" (claim 1) and exposing and observing a "target cross-section" (claim 6), which subject matter has already been considered by the Examiner, to conform the preambles of claims 1-8, 31-35 and 37 to the foregoing amendments to claims 1 and 6, to conform the language of claim 2 to that of base claim 1, and to overcome the indefinite rejection of claims 31-32. Thus, entry of the foregoing amendments does not impose a burden on the Examiner and should not be denied.

Applicants request reconsideration of their application in light of the foregoing amendments and the following discussion.

The present invention relates to a method of cross-sectional processing and observation.

As described in the specification (pgs. 2-3), a conventional method related to the method of the present invention involves the formation of a cross-sectional structure exposed portion in a desired area in a sample surface and observation of the exposed cross-sectional portion through a scanning ion microscope image using a focused ion beam or a scanning electron microscope (SEM) image using an electron beam. However, such conventional method has been associated with the problem of insufficient resolution for observation as a result of using the scanning ion beam microscope image or SEM image. The specific problem is that the resolution is insufficient to manage the very small thickness of the film structures being observed.

Another conventional method involves etching a desired area in a sample surface with a focused ion beam to take out a sample chip and observing the sample chip with a transmission electron microscope (TEM). However, this method has been determined to be time consuming and expensive to carry out.

Moreover, the foregoing conventional methods have only been capable of providing information on the geometry of a sample, not on electrical and mechanical characteristics of the sample.

The present invention overcomes the drawbacks of the conventional art. Fig. 1 shows an embodiment of a method of cross-sectional processing and observation according to the present invention embodied in amended independent claim 1. According to the method of the present invention, in a first step at least one predetermined area 13 in a surface of a sample 12 is processed to form a target cross-section. In a second step, the target cross-section is observed by scanning the target cross-section with a probe of a scanning probe microscope and detecting a physical quantity produced between the probe and the target cross-section.

Amended independent claim 6 is directed to another embodiment of a method of cross-sectional processing and observation. The method comprises a first step of processing at least one predetermined area in a surface of a sample to expose a target cross-section, a second step of removing a damaged portion remaining in the exposed cross-section and then forming a stepped portion according to a difference in materials among layers forming the exposed cross-section, and a third step of observing the exposed cross-section with a scanning probe microscope.

By the foregoing methods, a sufficient spatial resolution for observing the formed or exposed target cross-section of the sample is achieved as compared to the conventional art. Furthermore, the methods according to the present invention facilitate the acquisition of electric, magnetic, and mechanical information for a target sample plane.

The prior art of record does not disclose or suggest the combination of steps recited in amended claims 1-8, 31-35 and 37.

Rejection Under 35 U.S.C. §102(b)

Claims 1-4 and 31 were rejected under 35 U.S.C. §102(b) as being anticipated by Kane. Applicants respectfully traverse this rejection.

Independent claim 1 has been amended to recite a method of cross-sectional processing and observation and requires a first step of processing at least one predetermined area in a surface of a sample to form a target cross-section, and a second step of observing the target cross-section by scanning the target cross-section with a probe of a scanning probe microscope and detecting a physical quantity produced between the probe and the target cross-section. No corresponding steps are disclosed or described by Kane.

Kane discloses a method for measuring electrical characteristics of an electrical device (Figs. 1-4). According to Kane (col. 8. lines 5-20), the surface of a hole 130 formed in a semiconductor composite 1 is coated with a metal film using CVD and performed by a focused ion beam (FIB) device. A metal pad 125 is then deposited over the hole 130 to provide a processed area in the form of a probe contact. The electrical device is then probed by having a probe touch the probe contact 125 to measure the electrical characteristics of the electrical device.

Thus in Kane, after FIB processing the processed area (i.e., the probe contact) is probed to measure the electrical characteristics of the electrical device, and no observation of the processed area takes place. In contrast, amended independent claim 1 recites a second step of observing a target cross-section by scanning the target cross-section with a probe of a scanning probe microscope and detecting a physical quantity produced between the probe and the target cross-section.

Furthermore, while disclosing the use of an AFM/SPM probe to measure electrical characteristics, Kane does not disclose or describe the observation of a target cross-section in a surface of a sample, and further by using a probe of a scanning probe microscope, as recited in independent claim 1.

It is noted that in column 4, lines 34-42, Kane discloses that electrical interconnections are verified by electrical probe measurements using a conventional tungsten wire probe as well as by AFM/SPM probe tip measurements. However, there is no disclosure in Kane of using any probe for the purpose of observing a target cross-section of a sample. According to the present invention, when a target cross-section of the sample structure is observed by a scanning probe microscope after a processing operation (e.g., such as by the use of FIB), it is possible to observe the target cross-section of the sample structure easily and with high resolution.

In the absence of the foregoing disclosure recited in amended independent claim 1, anticipation cannot be found. See, e.g., W.L. Gore & Associates v. Garlock, Inc., 220 USPQ 303, 313 (Fed. Cir. 1983), cert. denied, 469 U.S. 851 (1984) ("Anticipation requires the disclosure in a single prior art reference of each element of the claim under consideration"); Continental Can Co. USA v. Monsanto Co., 20 USPQ2d 1746, 1748 (Fed. Cir. 1991) ("When more than one reference is required to establish unpatentability of the claimed invention anticipation under § 102 can not be found"); Lindemann Maschinenfabrik GmbH v. American Hoist & Derrick Co., 221 USPQ 481, 485 (Fed. Cir. 1984) (emphasis added) ("Anticipation requires the presence in a single prior art reference

disclosure of each and every element of the claimed invention, arranged as in the claim").

Stated otherwise, there must be no difference between the claimed invention and the reference disclosure, as viewed by a person of ordinary skill in the field of the invention. This standard is clearly not satisfied by Kane for the reasons stated above. Furthermore, Kane does not suggest the claimed subject matter and, therefore, would not have motivated one skilled in the art to modify Kane's method to arrive at the claimed invention.

Claims 2-4 and 31 depend on and contain all of the limitations of amended independent claim 1 and, therefore, distinguish from Kane at least in the same manner as claim 1.

In view of the foregoing, applicants respectfully request that the rejection of claims 1-4 and 31 under 35 U.S.C. §102(b) as being anticipated by Kane be withdrawn.

Rejections Under 35 U.S.C. §103(a)

Claims 5, 8 and 32-35 were rejected under 35 U.S.C. §103(a) as being unpatentable over Kane in view of the references to Matsui, Yang, Muckerhirm, Okazaki and Hitachi. Applicants respectfully traverse these rejections.

Kane does not disclose or suggest the subject matter recited in amended independent claim 1 as set forth above for the rejection of claims 1-4 and 31 under 35 U.S.C. §102(b).

Claims 5, 8 and 32-35 depend on and contain all of the limitations of amended independent claim 1 and, therefore, distinguish from Kane at least in the same manner as claim 1.

The secondary references to Matsui, Yang, Muckerhirm, Okazaki and Hitachi have been cited by the Examiner for teaching the various selected features recited in claims 5, 8 and 32-35. As recognized by the Examiner, however, these references do not teach the specific steps recited in amended independent claim 1, from which claims 5, 8 and 32-35 depend. Accordingly, these references do not cure the deficiencies of Kane as set forth above for independent claim 1, and one of ordinary skill in the art would not have been led to modify the references to attain the claimed subject matter.

In view of the foregoing, applicants respectfully request that the rejections of claims 5, 8 and 32-35 under 35 U.S.C. §103(a) as being unpatentable over Kane in view of the references to Matsui, Yang, Muckerhirm, Okazaki and Hitachi be withdrawn.

Claims 6-7 and 37 were rejected under 35 U.S.C. §103(a) as being unpatentable over Yamaguchi in view of Yang (claims 6-7) and Azuma (claim 37). Applicants respectfully traverse these rejections and submit that the combined teachings of Yamaguchi and Yang or Azuma do not disclose or suggest the subject matter recited in claims 6-7 and 37.

Amended independent claim 6 is directed to a method of cross-sectional processing and observation and requires a first step of processing at least one predetermined area in a surface of a sample to expose a target cross-section, a second step of removing a damaged portion remaining in the exposed cross-section and then forming a stepped portion according to a difference in materials among layers forming the exposed cross-section, and a third step of observing the exposed cross-section with a scanning probe microscope. No corresponding combination of steps is disclosed or suggested by the combined teaching of Yamaguchi and Yang.

Yamaguchi discloses a method for correcting defects of an X-ray mask. A focused ion beam is used to irradiate at least a region having a defective portion of the X-ray mask. However, Yamaguchi does not disclose or suggest the foregoing combination of steps: a processing step resulting in the exposure of a target cross-section in a surface of a sample; a step of removing a damaged portion remaining in the exposed target cross-section; and a step of observing the exposed target cross-section using a scanning probe microscope, as recited in amended independent claim 6.

Moreover, contrary to the Examiner's contention, column 9, line 52 does not disclose or suggest the formation of a stepped portion as recited in the second step of claim 6.

While Fig. 9 of Yamaguchi illustrates the provision of a stepped portion, such stepped portion is formed by irradiation of the focused ion beam during repair of the mask. In contrast, the second step of claim 6 recites removing a damaged portion remaining in the exposed cross-section and then forming a stepped portion according to a difference in materials among layers forming the exposed cross-section.

The secondary reference to Yang has been cited by the Examiner for its disclosure of a step for observing a surface using an atomic force microscope. However, since Yang does not disclose or suggest at least the second and third steps recited in claim 6, it does not cure the deficiencies of Yamaguchi. Accordingly, one ordinarily skilled in the art would not have been led to modify the references to attain the claimed subject matter.

Claims 7 and 37 depend on and contain all of the limitations of amended independent claim 6 and, therefore, distinguish from the cited references at least in the same manner as claim 6.

Moreover, there is a separate ground for patentability of dependent claim 7 which includes the additional limitation that the method further comprises the step of finishing the exposed cross-section into a mirror face before the stepped portion is formed. No corresponding step

is disclosed or suggested by the prior art of record. For example, in column 7, lines 47-51 Yamaguchi discloses that the ion beam is irradiated onto the defective portion and can be corrected and worked. However, Yamaguchi does not disclose or suggest finishing an exposed cross-section into a mirror face before the formation of a stepped portion, as recited in claim 7.

In view of the foregoing, applicants respectfully request that the rejections of claims 6-7 and 37 under 35 U.S.C. §103(a) as being unpatentable over Yamaguchi in view of Yang or Azuma be withdrawn.

In view of the foregoing amendments and discussion, the application is believed to be in allowable form. Accordingly, entry of this amendment and favorable reconsideration and allowance of the claims are most respectfully requested.

Respectfully submitted,

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FEBRUARY 28, 2007
Date